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NP-2011-06-149-GSFC

National Aeronautics and Space Administration

REFLECTING on 2011

Accomplishments Report

Goddard Space Flight Center's
Innovative Partnerships Program Office

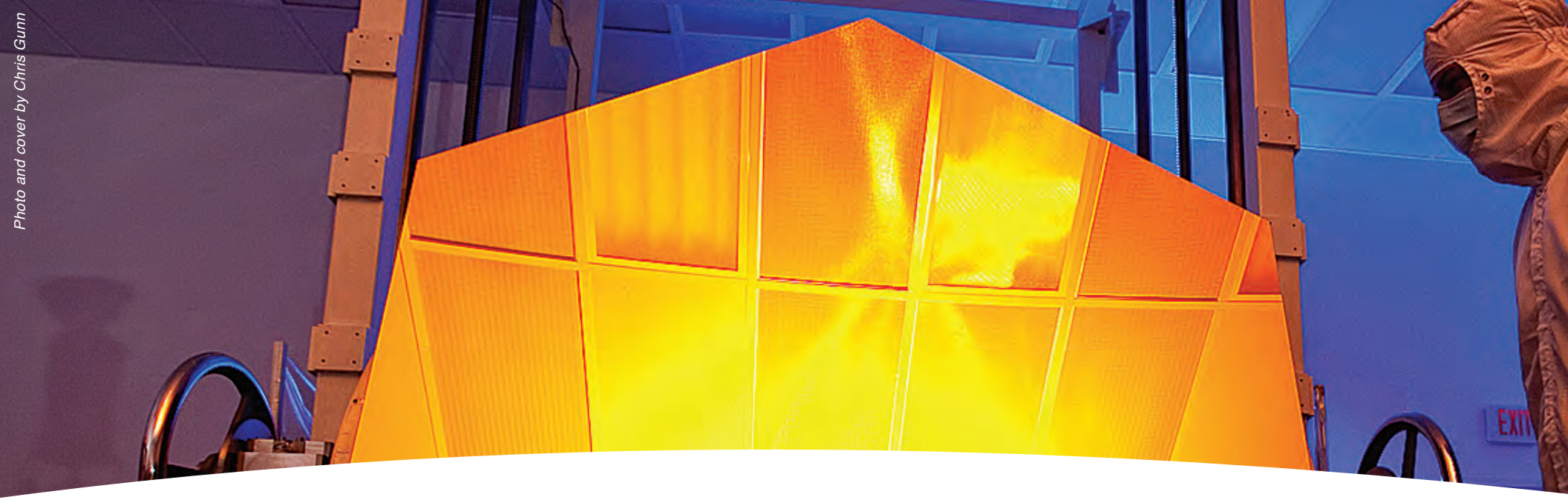

Photo and cover by Chris Gunn

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REFLECTING on 2011

Nona Minnifield Cheeks
CHIEF

Innovative Patnerships
Program Office
NASA Goddard Space
Flight Center

From the Chief

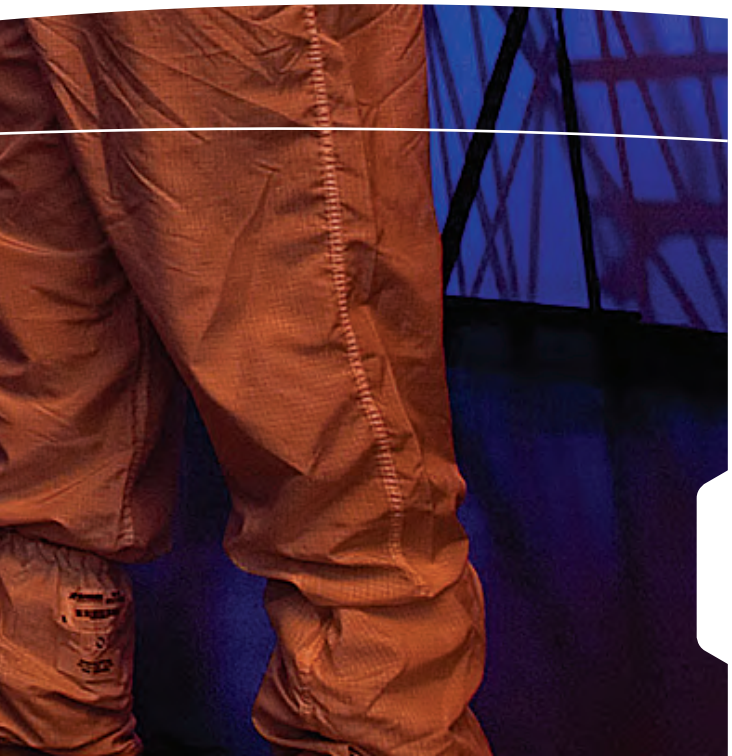
The year 2011 has been a very busy and eventful one for the Innovative Partnerships Program Office (IPPO). Our ongoing efforts to bring new technologies and capabilities into NASA Goddard Space Flight Center — and to make NASA Goddard technologies available for commercialization — have resulted in the IPPO working with a broad spectrum of highly talented companies, organizations, and people.

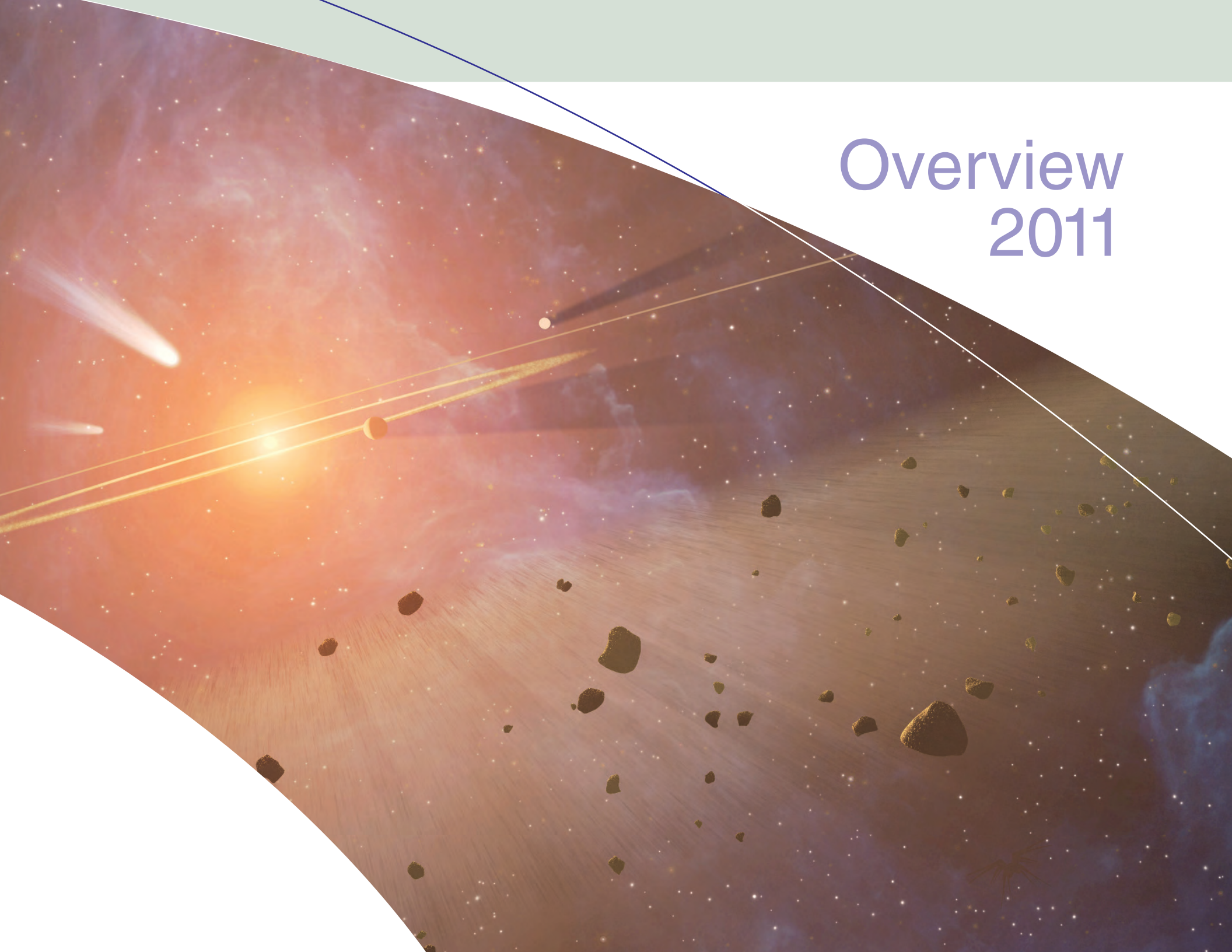
In the past year, we've engaged in forms of collaboration that represent new territory for us, such as our association with publisher Tor-Forge Books to produce NASA-inspired works of science fiction. We reestablished collaborating with academia by signing an agreement with the University of Baltimore's Merrick School of Business. In this program, Master of Business Administration candidates provide their unique "outside the box" perspectives to suggest novel applications and markets for NASA Goddard technologies.

In addition, we continue to work closely with more "traditional" partners, including intermediary organizations that represent specific regions, industry segments, and scientific and technical interests. These organizations help ensure that we find the best possible candidates for partnering with NASA Goddard.

This accomplishment report looks back on some of the more noteworthy accomplishments for NASA Goddard's IPPO during 2011. This includes a summary of the major technology themes presented in the previous issues of the NASA Goddard Tech Transfer magazines we published this past year. These themes include wavefront sensing, the Goddard Mission Services Evolution Center (GMSEC), and state-of-the-art software development. For each theme, we review several of the more interesting technologies and how they impact space and non-space applications. This report also reflects on the process of partnering with NASA Goddard, and highlights a few examples of 2011 events that were designed to promote NASA Goddard capabilities and collaborative opportunities.

The image of the James Webb Space Telescope mirror segment shown on the front cover symbolizes the overall theme of this report — reflecting on the past, while clearly focused on what lies ahead. This represents the IPPO's attitude as well, as we look forward to furthering our collaboration and partnership successes throughout 2012 and beyond.





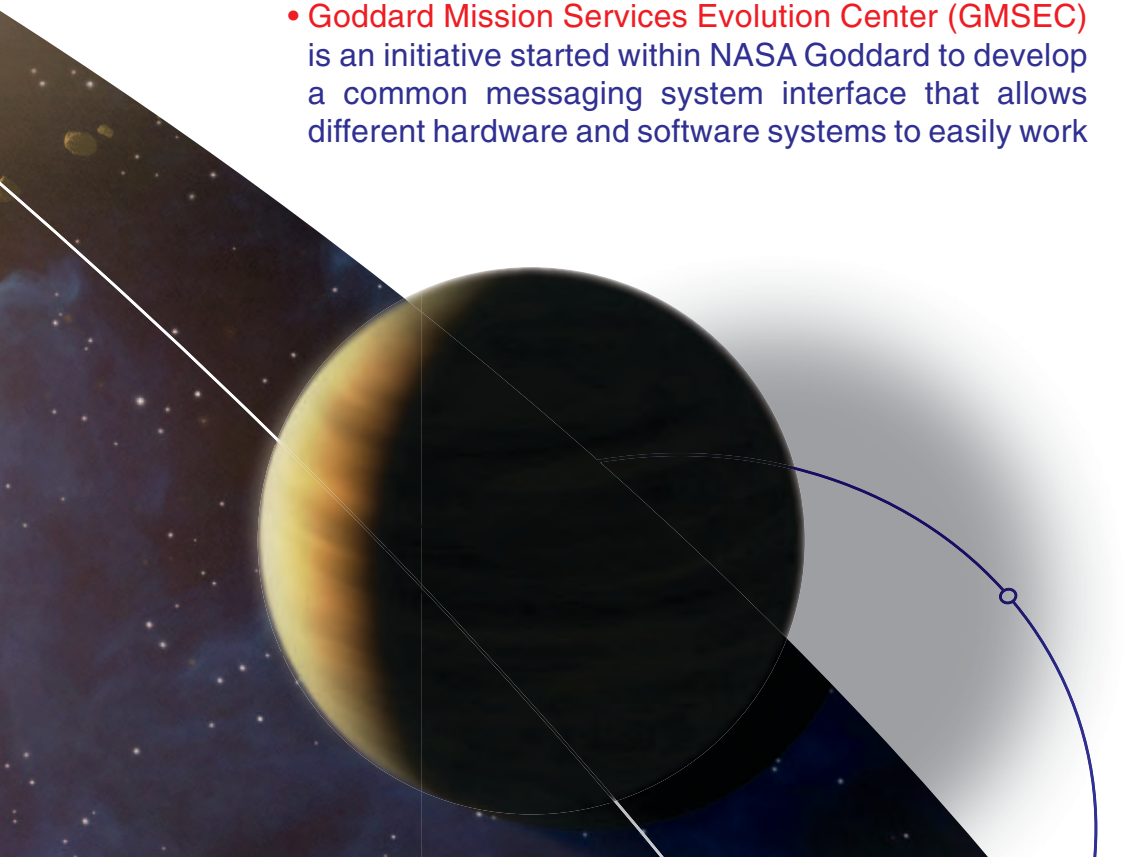
Overview 2011

In this special *Accomplishments Report* issue, we look back on a few of the more noteworthy tech transfer accomplishments, opportunities, and events from calendar year 2011. In particular, we focus on three technical areas in which NASA Goddard scientists and innovators have been especially active:

- Wavefront, an important component of NASA Goddard's optical development, involves obtaining the most data possible from the electromagnetic spectrum. Wavefront technologies have long been one of NASA Goddard's most essential areas of expertise, supporting many missions through the years. Many of these technologies can now be adapted to a wide variety of commercial applications.

- Goddard Mission Services Evolution Center (GMSEC) is an initiative started within NASA Goddard to develop a common messaging system interface that allows different hardware and software systems to easily work together. GMSEC offers the potential of shortening the development for new ground support systems by several orders of magnitude through "modularizing" system development. It also provides an opportunity in which commercial software developers can sell to NASA Goddard — and potentially other government agencies.

- Software Development is a broad area within NASA Goddard that includes tools that allow for the creation of working code much faster and easier — and in some cases, without requiring any previous programming experience. We provide a quick tour of several especially interesting and creative examples of our ongoing software development effort, and look at a few potential commercial markets and applications to which they could be adapted.



We also briefly review the work of the NASA Goddard IPPO and the many ways in which they identify the best possible partnership opportunities for the Center. Among these efforts are events such as NASA Goddard Industry Day 2011, in which NASA Goddard technologies were presented to potential partners from a variety of industry segments.

Wavefront

Throughout its existence, many of NASA Goddard Space Flight Center's most important missions have involved capturing and analyzing electromagnetic radiation, and using this data to explore and understand the universe. These missions include some of NASA Goddard's most high-profile success stories, including the Hubble Space Telescope (HST) and the upcoming James Webb Space Telescope (JWST).

The Wavefront Sensing and Control Group, along with numerous other NASA Goddard scientists and inventors, have produced a wide variety of wavefront sensing technologies that support our current and future space science missions. These technologies comprise a substantial and versatile intellectual properties (IP) portfolio. And the features and advantages that these inventions provide — many of which have been designed to maximize optical performance while minimizing size, weight, and energy requirements — make them attractive to many potential terrestrial applications.

In this section, we look at several interesting examples of wavefront technologies NASA Goddard has in development. We review several potential markets for our wavefront portfolio, including astronomical research, ISR (intelligence, surveillance, and reconnaissance), metrology, and optometry/ophthalmology. We'll briefly summarize the opportunities provided by each of these markets, and how wavefront sensing technologies such as adaptive optics can provide significant value within each. We also look back at last October's Wavefront and Adaptive Optics Industry Day Workshop, in which attendees had one-on-one technical discussions with NASA Goddard wavefront scientists and engineers, and explored licensing/partnering opportunities with the NASA Goddard IPPO. This workshop was part of NASA Goddard's ongoing "Can you See it Now?" campaign to bring awareness to NASA Goddard's expertise in wavefront sensing and adaptive optics capabilities.


Photo by Chris Gunn

Wavefront Technologies Market Opportunities

Over the years, one of NASA Goddard Space Flight Center's most critical areas of focus has been to develop technologies that capture and analyze the various forms of electromagnetic radiation (EMR) produced by the universe, and then analyze it. This of course is the main purpose of the HST and its successor, the JWST.

Wavefront technologies offer a broad array of partnership opportunities. In some instances, partnering involves collaborating with NASA Goddard to develop a technology to be used in support of a mission or goal. In other cases, the partnership could take the form of a licensing agreement in which (for instance) a company obtains the rights to a wavefront technology and develops one or more commercial products from it.

Wavefront Collaboration Example: the Hybrid Diversity Algorithm

The Hybrid Diversity Algorithm (HDA) builds upon technology originally developed for Hubble that has been adapted to the needs of the James Webb Space Telescope. The HDA estimates imperfections in an optical system via an adaptive iterative process. JWST presents some unprecedented and unique challenges. For example, JWST requires a 6.5 meter primary mirror, far too large and cumbersome to easily launch into orbit. So the primary has been designed as a set of 18 hexagonal mirrors with a common center of focus, which collectively work like a single mirror. This creates several alignment issues, so NASA needed to find a way to keep all of these segments working together and able to deliver a diffraction-limited resolution, to take full advantage of the space-based platform.

NASA approached this issue using a method called phase retrieval, in which a number of defocused images from the optical system are acquired, and then analyzed to determine the wavefront. The algorithms used to perform this analysis are subject to phase wrapping errors, which can result in two different wavefront measurements for the same system. Fortunately, the HDA provides phase retrieval without phase wrapping.

HDA offers commercial potential beyond the JWST mission. For wavefront technologies, these markets can be as diverse as medical imaging and metrology.

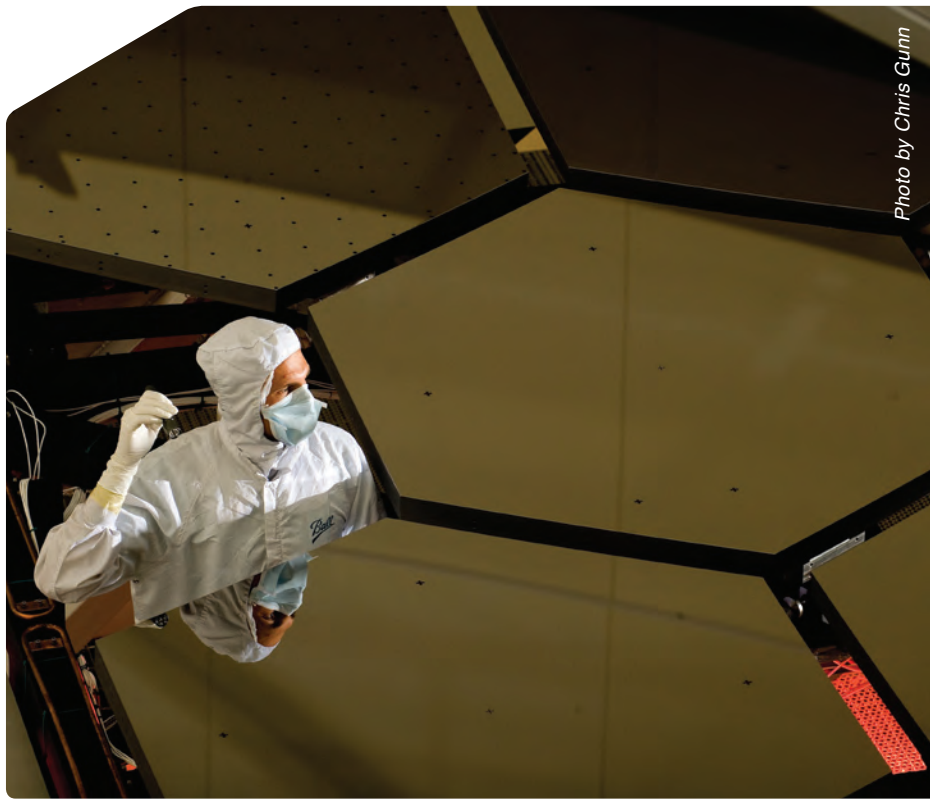


Photo by Chris Gunn

Photo by United States Army

There are a wide variety of NASA Goddard inventions which in theory could be adapted to the requirements and challenges of optometry and ophthalmology. For instance, the iterative Transform Phase-Retrieval Utilizing Adaptive Diversity (GSC-14879-1) is suitable for multiple applications, including as an alternative to interferometers in applications that require wavefront sensing and control. This is a phase-diverse-phase-retrieval iterative-transform algorithm for image-based wavefront sensing. It recovers high-spatial frequency, high-dynamic range wavefront data using only video or still camera inputs. This algorithm combines iterative-transform and parametric phase recovery techniques to allow for both high-spatial frequency and high dynamic range wavefront sensing. Wavefront calculations occur in the software, making the expensive hardware used in interferometry unnecessary.

Photo by United States Navy

Wavefront Technologies and Medical Imaging

The optometry community has begun to recognize the potential benefits of wavefront sensing, including earlier and better detection of the onset of eye disease, and personalized corrective lens (which correct for higher order aberrations than can be currently detected). Another interesting market is ophthalmology, the second science (after astronomy) to adopt adaptive optics techniques. Adaptive optics technologies could be used in a range of applications, offering the potential to diagnose a variety of specific diseases, and could be highly useful for clinical studies of rare diseases.

Metrology

The metrology community has adopted a number of techniques designed to coax optimum precision from their optical tools. One area of recent interest is adaptive optics, which is now being explored for its metrology potential. Although originally designed for space and astronomy applications, NASA Goddard adaptive optics technologies already offer significant promise in advancing the science of metrology.

Another field associated with metrology (and in particular, the expanding field of nanotechnology) is microscopy. For example, adaptive optical elements in a wide-field microscope solve a number of problems, including correcting aberrations due to the refractive index mismatches, focusing through thick samples without moving the sample or the objective, and correcting for aberrations caused by three-dimensional index variations within the sample, and also identifying phase and intensity objects over many orders of magnitude (high dynamic range imaging).

Phase retrieval is a promising tool for optical metrology, one that could prove to be very useful due to the simplicity of the approach, and by the variety of surfaces and systems that it could be used to measure.

Wavefront and Adaptive Optics Technology Briefing Outreach to Industry

The NASA Goddard Space Flight Center hosted the Wavefront and Adaptive Optics Technology Briefing Workshop on November 3, 2011. The Workshop was part of NASA Goddard's ongoing "Can you See it Now?" technology transfer campaign. The campaign is designed to raise awareness of NASA Goddard's expertise in wavefront sensing and adaptive optics.

During the Workshop, attendees from many different industries had the opportunity to review specific technologies and facilities related to NASA Goddard's wavefront portfolio. The featured technologies have been identified as offering potential application and commercial viability beyond NASA's needs. To help understand how these technologies could be adapted to commercial markets and products, attendees also had one-on-one discussions with NASA Goddard innovators. Among the NASA Goddard innovators on hand to meet with attendees were:

- **Dr. Bruce Dean**, Optical Physicist and Group Leader for the Optics Branch of the Wavefront Sensing and Control Group. He has published and spoken extensively in the field of wavefront sensing and control systems, and holds patent #7,635,832 for "Hybrid diversity method utilizing adaptive diversity function for recovering unknown aberrations in an optical system." He has also received numerous awards and accolades, including NASA Headquarters Exceptional Technology Achievement Medal (2009) and the NASA Goddard Honor Award for Engineering Achievement (2004). Dr. Dean is a current member of the Optical Society of American (OSA).

- **Mr. Rick Lyon**, Optical Scientist with a professional interest in research and development of complex astronomical imaging systems including filled, segmented and sparse aperture telescopes, coronagraphs, and imaging interferometers. He developed serial and parallel modeling and simulation approaches and algorithms for wavefront control, planetary detection, optimal detection, image deconvolution, and phasing of multiple aperture interferometric systems. Mr. Lyon has published 167 papers and 17 major technical reports, and spoken at 26 conferences.

GMSEC

The Goddard Mission Services Evolution Center (GMSEC) is a software architecture that enables different applications and components to seamlessly work together through a common messaging system interface. This allows developers to design, test, and implement a support system in a fraction of the time it would take to build it the “traditional” way, from the ground up. It also makes it far easier to upgrade and maintain a system for years or even decades, without locking into any one vendor, since components can now be swapped out and added as needed. This is a critical consideration for long-term missions.

GMSEC was originally designed to support NASA Goddard satellite missions. More recently, the use of GMSEC has spread well beyond NASA Goddard. One example is the U.S. Air Force, whose commitment to GMSEC now rivals NASA Goddard’s own. Other NASA centers and government agencies have also expressed interest in adopting the GMSEC platform. Today, GMSEC is responsible for one of the highest numbers of Tech Transfer Agreements among NASA Goddard technologies. And many commercial developers are already benefitting from the fact that it provides an important avenue for selling to NASA Goddard and other government agencies.

This section summarizes GMSEC’s current and future goals. We also take a quick look at GMSEC components and the benefits they offer, which differ from application to application, and agency to agency. In addition, we discuss some of the many technology transfer opportunities GMSEC provides.

Photo by Bill Hrybyk

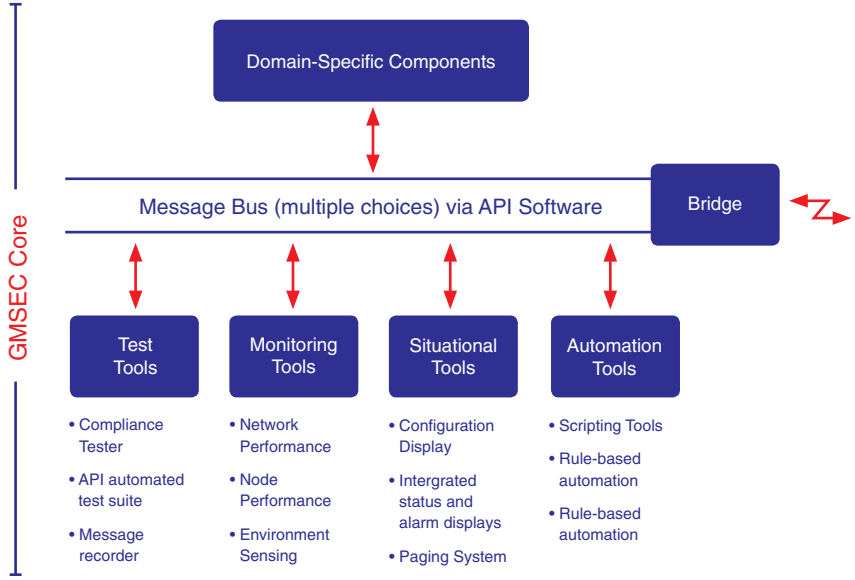
A New Environment for Developing and Implementing Satellite Controls

The year 2011 saw the continued development and adoption of GMSEC. GMSEC is an architecture designed to provide a layer of commonality and integration for ground operation center software systems.

GMSEC provides a standard software architecture for developing systems where applications communicate and exchange data over a messaging bus. The high-level advantages of this approach are probably readily apparent: By writing to a standard interface, developers can add and replace applications without disrupting other components of the system. Further, designers can build their systems by selecting from a catalog of existing applications, rather than having to create (or heavily modify) each application for each system. This means that systems can be put together much more quickly and cheaply, using components that in many cases have already been coded, debugged, and proven in the field.

GMSEC Architecture

The GMSEC framework/information bus consists of an API (application programming interface), standard messages, and underlying middleware. This includes eight NASA Goddard-created components: GREAT (GMSEC Reusable Event Analysis Toolkit), CAT (Criteria Action Table), ANSR (Alert Notification System Router), GEDAT (GMSEC Environment Diagnostic Analysis Tool), System Agent, GRASP (GMSEC Remote Access Service Provider), GPD (GMSEC Parameter Display), and RAA (Room Alert Adapter). In addition, there is a catalog of GMSEC-compliant vendor applications from which to choose when building a GMSEC-based system.



The GMSEC architecture allows for domain-specific components to be easily integrated with general purpose system support tools developed by the GMSEC team.

The API is the backbone of GMSEC; it allows applications to subscribe and publish to the middleware, irrespective of which middleware is selected. This helps reduce application development to its simplest form, relieving it of the communications burden: a component only needs to know how to send information to, or get information from, the information bus via the API. The API has been instantiated for several different programming languages, including C, C++, Java and Perl.

Automation is an important capability for GMSEC systems. Each software application publishes its status on the GMSEC message bus. Other components read and assess these messages and can send directives in response to discovered conditions. For instance, if the schedule reports that a satellite contact should be starting and then the start of data is not reported within 30 seconds, the system can automatically page the supervisor, check the status of the system hardware, and send a request for the antenna site to try again to acquire the data.

Benefits

GMSEC provides a number of important benefits to NASA Goddard missions. According to Dan Smith, GMSEC Project Manager, the most important of these benefits is that GMSEC makes it easier to create systems with high levels of automation, thereby reducing cost and risk. In addition, since more commercial command and control products are now GMSEC compatible, this increases the choice of applications for missions. At the same time, software engineers can still use "old favorite" legacy applications if they are GMSEC-compliant, which often makes developers more willing to adopt this approach.


Photo courtesy of ORS

Adopting GSMEC has already paid dividends. For instance, Jim Busch, who was a lead engineer for the Tropical Rainfall Measuring Mission (TRMM) ground system reengineering effort, stated after the redesign efforts that "TRMM has realized a reduction in flight operations costs of over 50% as compared with the pre-GMSEC architecture." A major reason for the cost reduction is the ability to use GMSEC components to enable new levels of automation and to support "lights out" operations for nights and weekends – the system can call the appropriate person if there is a problem.

GMSEC also enjoys strong support from commercial product vendors, but not by having them commercialize NASA Goddard technologies. Instead, vendors realize that offering GMSEC-compliant products allows them to more easily market their capabilities to NASA and other U.S. Government agencies. According to Dan Smith, "we have had vendors come forward and say 'We can do GMSEC for you,' but that's not what we want. We've made the core of GMSEC available as Open Source software. Doing so prevents GMSEC from becoming a proprietary company product."

Ultimately, however, the major benefit GMSEC provides to commercial software developers is the market it creates for them. "We're at the point of achieving critical mass," states Dan. "Our vendors are saying, 'If I support GMSEC, look at all the potential government customers I'll have.' It's really started to take hold."

GMSEC News in 2011

GMSEC Lab Gets a New Look

During the year, the GMSEC laboratory received a major upgrade. This included new equipment that will more closely model an actual satellite ground support environment. "The old lab looked like a software development facility, which is basically what it was" explains Dan Smith, Project Manager for GMSEC. "It really didn't have the look or feel of a mission control center." The upgraded facility, on the other hand, presents a far more realistic, real-world atmosphere. "The ultimate goal will still be to demonstrate GMSEC, of course" notes Dan. "But we'll be doing so in a room that emulates a ground mission, using data from real projects."

Dan Smith, GMSEC Project Manager

The upgraded lab now allows Dan and his team to demonstrate individual projects for ground system support. Simulations can use real data from actual missions. (For security reasons, this will not be real-time "live" data; but it will be information provided by working satellite systems.) In addition to offering a more operational appearance, the new lab can also simulate actual problems and conditions that might typically be encountered during a mission. Problematic data can be introduced into the system, allowing researchers to determine how well the GMSEC environment can handle it. "Simulated problems will look more like real problems," adds Dan.

To ensure authenticity, the GMSEC laboratory was set up by the same personnel who install functioning ground control centers, rather than software developers. Equipment includes the same display hardware used by ground systems. "We've had a lot of success spreading the word about GMSEC," states Dan. "And lab demonstrations have been an important part of that. Now, we'll be able to do those demonstrations in a more realistic environment, one that looks familiar to many of our potential users."

Air Force Hosts GMSEC Industry Day

In September 2011, the United States Air Force held a GMSEC "industry day" at their Chantilly, VA facility. In attendance were approximately 35 government representatives, along with a number of commercial software vendors. The goal of the meeting, which ran from September 13 through September 16, was to allow vendors to demonstrate the GMSEC-compatibility of their software solutions, focusing on how each product performs its function within a GMSEC environment, rather than simply "showing off" the product for marketing and sales purposes.

To do this, each product vendor was presented with a specific satellite-related scenario in which a "national situation" is underway. The vendor was then presented with a data stream, and then asked to demonstrate how their product solves this scenario-based problem. The success of these demonstrations offered some very powerful evidence for the value and utility of GMSEC.

During the meeting, vendors were asked two questions:

- How long does it take to integrate GMSEC compatibility into your product?
- Should the government be pursuing GMSEC compliance?

The answer to the first question was very consistent across vendors; most reported that it takes two weeks or so to fully integrate GMSEC into a product. This appears to indicate that GMSEC compliance would represent a relatively quick and painless step within the software development process.

In response to the second question, vendors were unanimous: the government should most definitely continue exploring GMSEC compliance. In fact, vendors stated that the entire software industry should be interested in developing initiatives such as GMSEC, to allow more interoperability and "plug and play" capability among components provided by multiple developers.

Other News

During the year, Barbie Medina was named the GMSEC Project Deputy. Among her primary responsibilities is to help increase the GMSEC team's interaction with the NASA Goddard mission teams, and identify new products for development.

In 2011, Dan Smith gave a presentation in which one of the goals talks about sharing technologies with other agencies, to help transform America's space capabilities. The purpose of this talk was to stress GMSEC's utility beyond solely supporting NASA missions.

And during the year, the GMSEC team continued to increase their involvement with outside organizations, including other NASA Centers and government agencies. The team received requests from an Air Force organization, the Food and Drug Administration, and several commercial product venders; all wanting to discuss the potential use of GMSEC and long-term collaborations.

Software Development

NASA Goddard Space Flight Center is currently developing several leading-edge software strategies, designed to help robotic and other software-controlled systems perform more independently and intelligently in very remote and harsh environments. In this section, we review several key areas of NASA Goddard's software development efforts. These include automated code generation and autonomous computing, which involves developing systems that can emulate biological processes.

These technologies offer a broad variety of tech transfer opportunities for the commercial sector. For example, the multi-billion dollar robotics market may present a ready application for NASA Goddard technologies designed to allow devices to be programmed more quickly, or act more independently and make decisions based on the dynamic environments in which they operate. We examine how these features can be of value to all six major segments of the robotics industry, including space robots, industrial robots, military robots, security robots, domestic service robots, and professional service robots. And we look at how NASA Goddard's work in automated code generation could provide a novel way for non-programmers to create code through various forms of input such as natural language.

We also discuss several autonomic technologies developed by NASA Goddard to mimic biological functions such as heartbeat, pulse, and apoptosis (a feature that prompts an unneeded or inactive component to shut down and remove itself from the system if a pre-defined expiration period passes without the component receiving a "reprieve" signal). These technologies can be applied to a number of critical applications involving security, maintenance, and troubleshooting.

Photo from Wikimedia Commons

NASA Goddard Software Technologies Market Opportunities

NASA Goddard has decades of experience developing state-of-the-art computer software technologies and systems. Over the years, and continuing through 2011, these technologies have become increasingly advanced and sophisticated, in response to the growing demands for missions to function with little or no direct human operation. Currently there are several NASA Goddard technologies designed to allow robots to act more independently and make decisions. These include so-called "autonomic" technologies that emulate certain biological processes found within the human body.

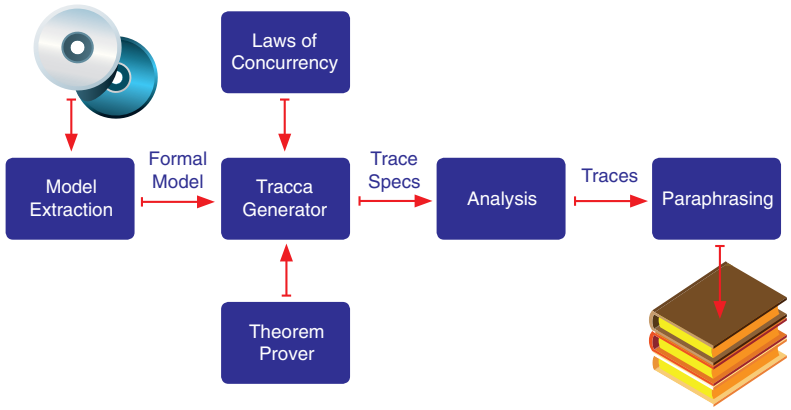
NASA Goddard has also taken the lead in creating systems that make the software development process itself much quicker, easier, and cheaper. A key component of this initiative is automated code generation, a technique that allows non-programmers to create working software.

These software technologies have clear commercial potential. It probably goes without saying that any technology that enables relatively untrained personnel to create sophisticated and fully operational computer programs would be of high interest to the software development industry. Similarly, technologies originally developed for space robotics can be adapted to the multi-billion dollar (and growing) commercial robotics market. In addition, autonomic computing concepts can be applied to a number of computer and network administration applications.

Automated Code Generation

Basically, code generation tools allow non-programmers to create code, using various forms of input and interfaces. This input is then translated into functional code. Although such tools have been available for a number of years, the code they produce tends to be inefficient and error-prone. This is largely due to the difficulty in translating informal input, such as natural language, into code. As a result, such tools have yet to revolutionize the software industry; the vast majority of code, even relatively simply programs, still requires the expertise of a professional programmer.

NASA Goddard's Computing Environments and Collaborative Technologies Branch has developed a number of technologies designed to greatly reduce the time and effort required to create software programs. These technologies can automatically create formal specifications and working code from informal natural language descriptions or flowcharts of the code logic. This means that programs could be created from their functional specifications, and that code design and creation can essentially be combined in a single step. This can also be a very useful tool for professional programmers, since they can now simulate their programs during the design stage to determine whether or not they are working as intended. This can significantly reduce debugging, since the program logic will already have been proven beforehand. In addition, NASA Goddard's code generation technology can be "run in reverse" to create a description of existing code -- in other words, a programmer can input source code, which will be converted into a formal mathematical model. This model can then be translated more readily into a description of the code.



This diagram shows how NASA Goddard's code generation technology can be used to reverse engineer software documentation for existing code.

According to a recent report by the research firm TechNavio, the commercial software market market for application design/development tools (often abbreviated as ADT) was estimated at almost $7 billion in 2010, growing at an annual rate of 4.6%. ADT includes third generation languages, unified development environments, web site design tools, and analysis, modeling, and design tools. NASA Goddard's patented automated code generation technologies are positioned to address all four of the key drivers of the ADT market:

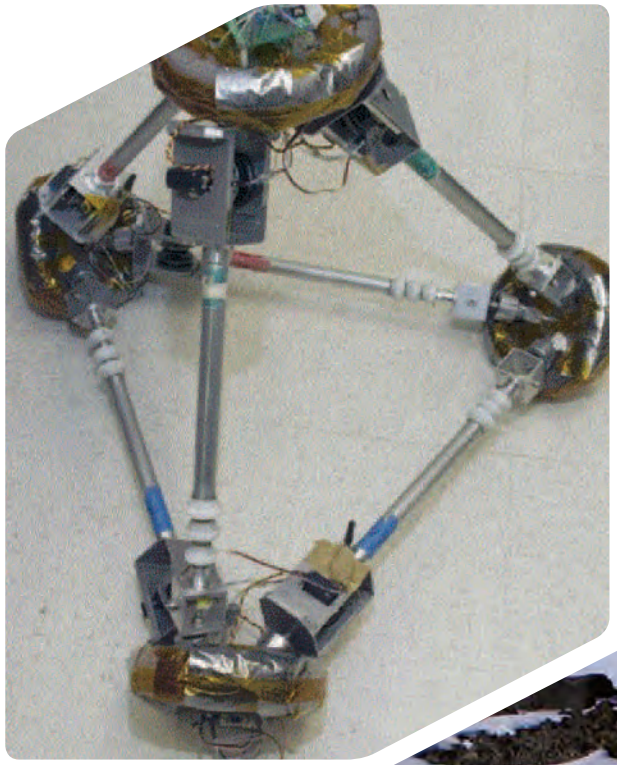
- The need to rapidly develop applications to support changing business needs
- Increased complexity and size of software projects
- Dynamic business environments within enterprises
- Integrating software programs

Software Enables Robotics

NASA Goddard has developed numerous software technologies designed to support space science operations. A crucial capability needed for the success of these missions is the ability to allow robots to act with more autonomy, making decisions based on the demands of the dynamic environments in which they operate.

A recent report from the Web site CompaniesAndMarkets.com estimates the global market for robotic devices at approximately $21 billion. This same report projects that this market will grow to $30 billion by 2016. The robotics industry consists primarily of six major segments. These include space robots, industrial robots, military robots, security robots, domestic service robots, and professional service robots. These segments comprise a widely diverse market in which technologies designed to make it easier to control these robots — or allow them to control themselves — could be in high demand.

One key NASA Goddard technology that makes programming robots much easier and quicker is automated code generation, described earlier in this article. In addition, NASA Goddard has developed several artificial intelligence (AI) technologies applicable to robotic devices. A number of these AI features have been created with space missions in mind, where ground-based control is inconvenient and/or impossible due to the distances involved. AI could be equally valuable here on Earth, especially for environments (such as the deep sea, high radiation areas, structurally compromised enclosed spaces, and so on) where human control would either be too slow, dangerous, or technologically infeasible.



The Tetrahedral Walker relies in NASA Goddard software to maneuver autonomously over harsh terrain. It was tested and proven at McMurdo Station in Antarctica.

Autonomic Computing

Autonomic computing is a concept that has been developed over the past 10 years as a way to manage increasingly complex computing systems. The core idea borrows from biology, specifically the human body's autonomic nervous system. In an autonomic system, basic functions are self-managed in accordance with a pre-defined set of policies and rules established by system administrators and designers. The computer system then uses these policies and rules to manage and maintain itself, without direct action from administrators. Since this minimizes the amount of administrative oversight, autonomic computing can be an important strategy for managing extended and complicated systems, such as those associated with cloud computing.

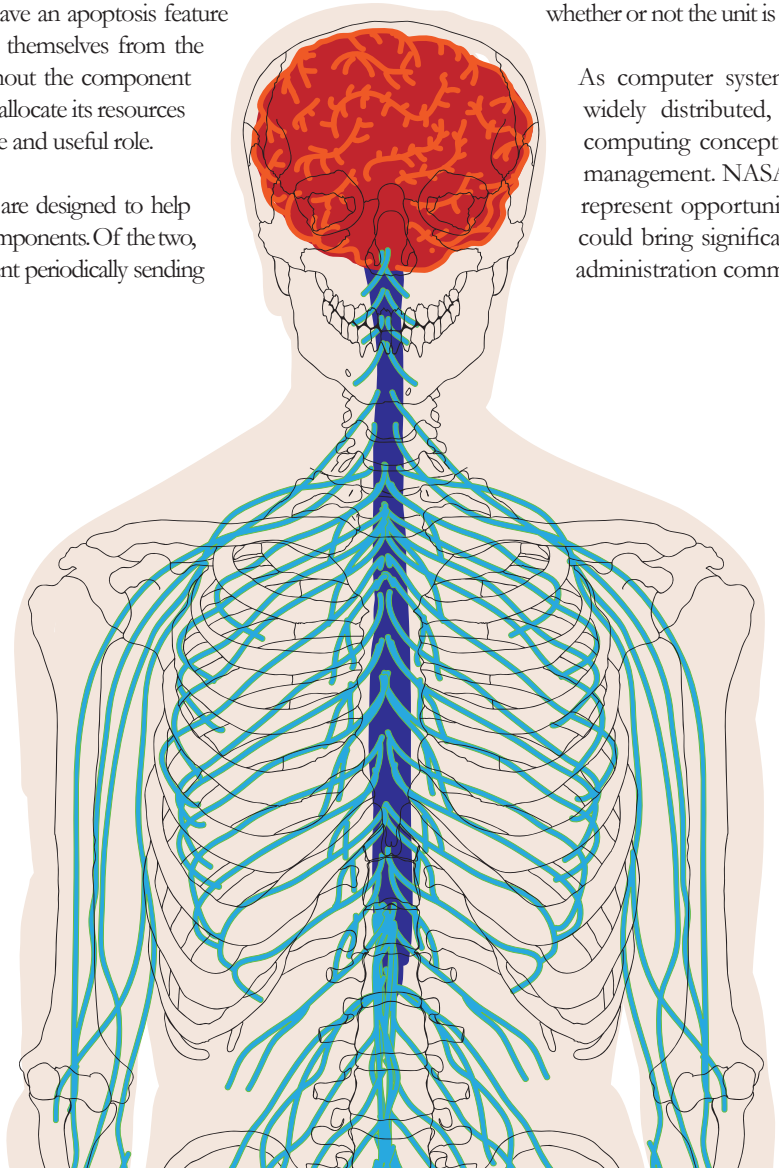
Photos by NASA

NASA Goddard has developed a number of technologies that mimic autonomic biological functions, such as apoptosis, heartbeat, and pulse. The first of these concepts, apoptosis, models the pre-programming that instructs cells to die once they have fulfilled their useful life and function. NASA Goddard has adapted this concept as a way to help manage large, complicated computer systems. Many of these systems include components designed to be used only once, or only for a limited period of time, or only in special situations. Allowing these entities to remain part of the system after they have served their purpose can consume resources. To avoid this, components can have an apoptosis feature built in that causes them to shut down and remove themselves from the system if a pre-defined expiration period passes without the component receiving a "reprieve" signal. This allows the system to allocate its resources only to those components that are still playing an active and useful role.

The two autonomic concepts of heartbeat and pulse are designed to help systems communicate with and manage their separate components. Of the two, heartbeat is the simpler concept. It involves a component periodically sending a "heartbeat" signal to the system. This heartbeat signal alerts the system that the component is online and functioning. If the system fails to receive the heartbeat signal, it assumes that the component is no longer operational, and adjusts. Heartbeat can be an important tool in systems and networks that consist of multiple objects and entities that are physically distant and disparate. Pulse is related to heartbeat, but with an added layer of complexity. As with the heartbeat, a pulse can let the system know that the component is still operational and communicating. However, the pulse also contains additional data about the overall "health" of the component, such as whether or not the unit is experiencing some problem.

As computer systems and networks become more complicated and widely distributed, as in cloud computing applications, autonomic computing concepts will likely play an increasingly larger role in their management. NASA Goddard autonomic computing technologies may represent opportunities for the development of commercial tools that could bring significant value to the computer system management and administration community.

Inspiration from the human/mammalian autonomic nervous system.



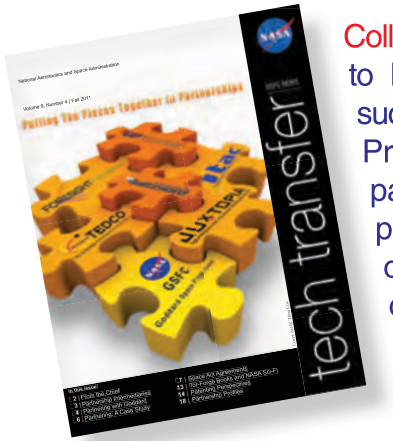
Fight or Flight

The Sympathetic division mobilizes body systems during activity

Rest and Digest

The Parasympathetic division conserves energy and promotes housekeeping functions during rest

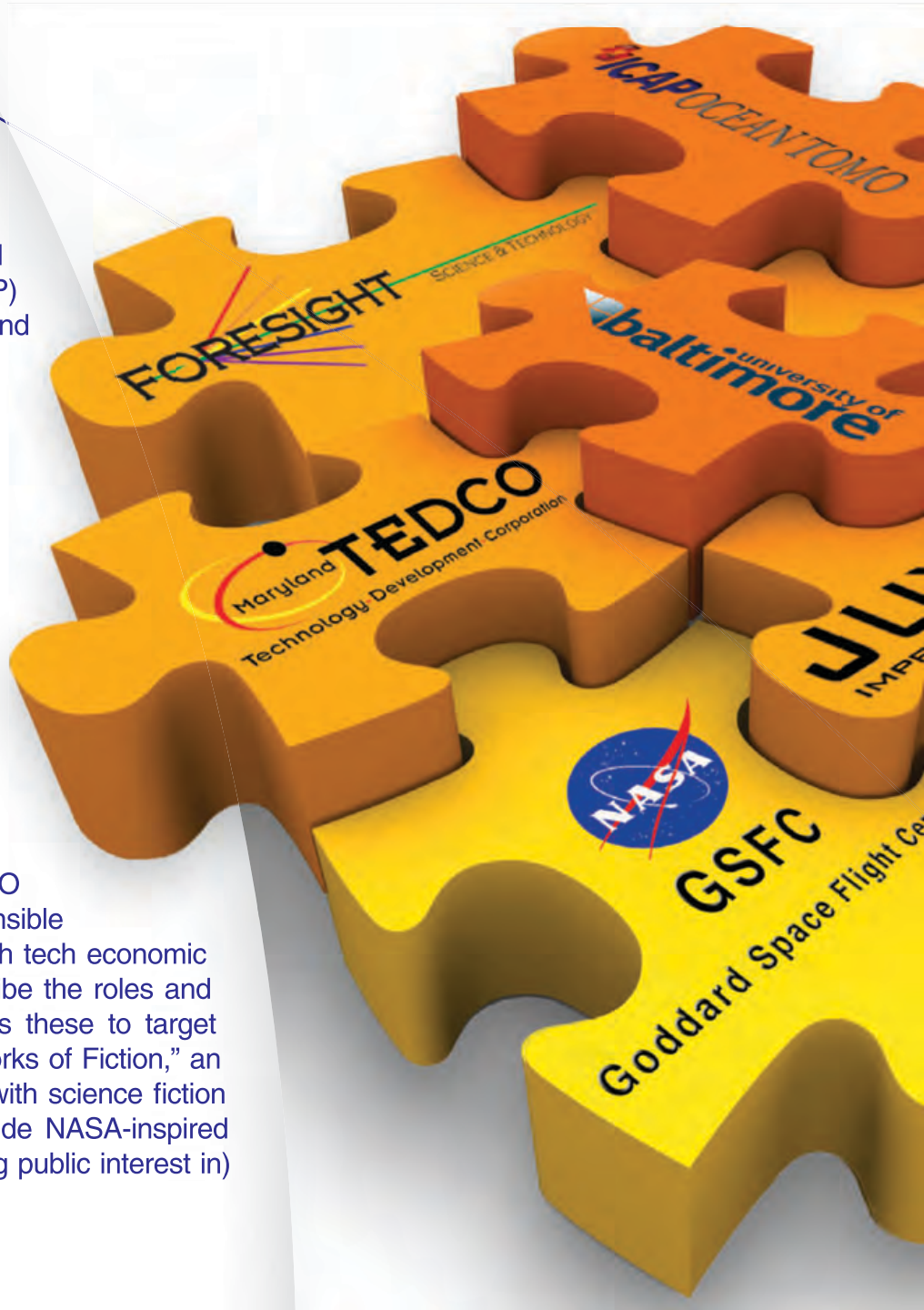
Intermediaries



Collaboration and partnering are absolutely vital to NASA Goddard Space Flight Center's ongoing success. The NASA Goddard Innovative Partnerships Program Office (IPPO) manages the licensing and partnering of Goddard's intellectual property (IP) portfolio. The IPPO works with industry, academia, and other government agencies to identify partnership opportunities and to construct partnership agreements to help advance new technology designs and products of mutual interest.

Partners can come in all sizes, regions, and community segments. To ensure that NASA Goddard has access to the broadest and deepest pool of collaboration candidates from which to choose, the IPPO takes advantage of all possible tools and techniques for reaching out to potential partners. This often involves dealing directly with interested parties, through venues such as the November 2011 Wavefront and Adaptive Optics Technology Briefing Workshop. The IPPO also works with a number of intermediaries whose missions are to promote business development within a certain industry, community, or region.

In this section we discuss several examples of partnerships the IPPO has in place with diverse intermediary organizations that are responsible for advancing technology development and application to support high tech economic development within their respective geographical regions. We describe the roles and objectives of the intermediaries, and how NASA Goddard leverages these to target collaborative opportunities. We also briefly review "NASA Inspired Works of Fiction," an outreach project that pairs NASA Goddard scientists and engineers with science fiction writers. This will result in a new science fiction series that will include NASA-inspired content, with the ultimate goal of raising awareness of (and enhancing public interest in) science, technology, engineering and mathematics (STEM).



— Graphic art by Trina Cox

NASA Goddard Space Flight Center Partners with Intermediaries

During the past year, NASA Goddard collaborated with a number of partners in the ongoing effort to expand our expertise and technology base. The IPPO entered into these partnerships with three primary goals in mind: to leverage NASA Goddard's R&D, to accelerate R&D work, and to bring in new technologies. To help meet these goals, the IPPO looks for opportunities to collaborate with others (including NASA centers, other government agencies, academia, and private enterprise) to develop complementary and adjacent technology.

One of the methods the IPPO uses to find and engage the best potential partners is through the help of intermediary organizations. These intermediaries, who often represent a specific region or market segment, can be essential for matching the most appropriate partner for NASA Goddard.

Commercialization

Throughout 2011, the IPPO collaborated with their commercialization partner Foresight Science & Technology on a number of tech transfer initiatives. Examples of Foresight's collaboration with the IPPO during 2011 included:

- Industry outreach programs, in which Foresight helps NASA Goddard showcase and highlight technologies and areas of expertise to potential commercialization partners in targeted industry segments. An example of this was the Wavefront and Adaptive Optics Technology Briefing Workshop, held in November at the Greenbelt, Maryland campus.

- Assessment reports that review the viability of potential markets and applications for specific NASA Goddard technologies. These assessments help identify the most promising potential markets for each available technology.

- Periodic journals and other publications that highlight the latest developments and partnership opportunities at NASA Goddard. Each journal and article focuses upon a particular area of interest within the NASA Goddard IP portfolio.

Foresight (founded in 1980) is dedicated to "stimulating innovation and the uptake of new technologies in the United States and around the world." Customers include over 145 companies (ranging from the Fortune 100 to start-ups), over 80 universities and foundations, and over 40 government agencies and laboratories.

Manufacturing Innovation

There are numerous NASA Goddard technologies that offer significant potential to manufacturers. Two obvious examples are control software and robotics. Industrial robots are typically used in manufacturing processes, such as automobile factories. Common tasks for these devices include welding, cutting, lifting, sorting, and bending. To help ensure that potential partners in the manufacturing sector are matched to the appropriate NASA Goddard technologies, the IPPO frequently collaborates with institutions and organizations whose mission is to help support and develop manufacturing and technology on a national or regional level. One example of such an organization is the Industrial Technology Assistance Corporation (ITAC), based in New York City.

A primary goal of the NASA Goddard/ITAC partnership is to match ITAC client companies with appropriate NASA Goddard technologies. This involves informing ITAC companies about technologies that may be of interest to their businesses. These opportunities cut across a wide spectrum of markets and applications. As part of this process, ITAC's Technology Program Director, Franklin Madison, Jr., recommends that anyone interested in licensing a NASA Goddard technology should come prepared by reviewing the technologies listed on the IPPO web site (see http://ipp.gsfc.nasa.gov/). He also suggests initiating an ongoing dialog with the IPPO, for further information and answers concerning technologies of interest.

New Kinds of Start Up Companies

Traditionally, start-up companies have not always received upfront prominence and stature within industry that might otherwise be merited. To minimize this issue, NASA Goddard often collaborates with organizations and agencies dedicated to supporting business development and opportunities within this sector. One example of this is NASA Goddard's relationship

with the Juxtopia® Urban Innovation and Cooperative Entrepreneurship (JUICE) Network. The JUICE Network helps promote space entrepreneurship opportunities for under-represented and disadvantaged communities. Specifically, their goal is to help minority-owned companies understand how they can benefit from collaborating with NASA Goddard. This includes (but is not limited to) access to NASA Goddard technology transfer and equipment/facility resources.

Dr. Jayfus Doswell is founder and board chairperson of Juxtopia®. As such, his company serves as an example of collaboration with NASA Goddard. According to Dr. Doswell, this collaboration not only created a potential new market for Juxtopia®; it also gave the company exposure and access to "a lot of unique/advanced high tech resources. For example, NASA Goddard has many advanced optical technologies that we're looking at to help improve some of the optical subsystems that comprise our technology. These NASA Goddard inventions may allow us to do things we couldn't do with off-the-shelf components sold in stores. This gives us an excellent opportunity to really improve the performance of our products."

Dr. Doswell also speaks highly of his experiences collaborating with the IPPO, particularly with the Office's attentiveness to open and prompt communication. "Basically, if we have any question about any invention that interests us, we work through our contact person in the IPPO to get the answer. This has resulted in timely dialogue for addressing technical inquiries that have lead to licensing meetings with the IPPO team and inventors."

Focus on Small Business Partners

Small businesses often make excellent commercialization targets for NASA Goddard technologies, particularly those ideally suited for specialized niche markets and applications. To reach small companies, the IPPO collaborates with organizations dedicated to the promotion and development of small technology businesses in a particular state or region. An example is the Maryland Technology Development Corporation (TEDCO). TEDCO is an economic development arm of Maryland, focused on technology-based economic development. TEDCO, which has a Space Act Agreement with NASA Goddard, looks for small businesses interested in partnering with the Center. This can involve a patent licensing deal, or other forms of collaboration. TEDCO can also provide third-party financing to help support these partnerships through funding programs.

According to Ronald Kaese, Director of Federal Programs for TEDCO, "Small businesses approach TEDCO routinely to seek help in advancing their technology business. They seek access to facilities for testing a technology. Or maybe they need technology. At that point, we discuss whether there may be a mutually beneficial relationship with NASA Goddard."

TEDCO has also conducted and promoted several technology showcases. These events have helped ensure that potential collaborators with NASA Goddard attend the showcases. Outcomes have been license agreements and several partnering discussions and agreements.

Mr. Kaese cites NASA Goddard's unique facilities, technologies, and data sets as especially valuable to small businesses. "Small businesses need to prove concepts, advancing their technologies to mature levels, or testing. This becomes a big deal for small businesses looking to attract investors. NASA Goddard can support the technical merit for this requirement if the small business line of business aligns with NASA Goddard assets they can license or leverage. Potential investors and small businesses can quickly determine if in the real world the small business new idea/product scales up."

TEDCO complements ongoing discussions among laboratories, NASA Goddard, and other government agencies to help promote technology and facility needs across laboratories, focusing on marketing of similar technologies from the laboratories to small businesses. They also host and sponsor technology transfer partnership forums to discuss business processes and technology exchange opportunities among the laboratories and small businesses.

Other forms of Collaboration

Academia. In addition to intermediaries, the IPPO also partners with educational institutions. For example, NASA Goddard is collaborating with the University of Baltimore's Merrick School of Business to analyze and consider the commercial potential for a variety of NASA Goddard technologies. In this program, MBA candidates are presented with a number of NASA Goddard technologies. The students then devise potential applications and markets for these technologies. NASA Goddard scientists and engineers will work directly with University of Baltimore faculty and MBA students to provide them with detailed information about their inventions. The goal is to equip the students with sufficient technical background about the invention and its capabilities

to define potential new uses for it. In return, NASA Goddard will meet with faculty and students to develop a better understanding of potential new applications of the NASA Goddard technologies that were part of the course material.

Book Publishing. In 2012, NASA also announced a partnership with Tor-Forge Books, a well-known publisher of science fiction. This outreach project, called "NASA Inspired Works of Fiction," will pair NASA Goddard scientists and engineers with Tor-Forge writers to help raise awareness of (and enhance public interest in) science, technology, engineering and mathematics (STEM). The end result will be the creation of a new science fiction series that will include NASA-inspired content. The first of these works should be published in late 2013. As part of this program, NASA Goddard hosted a two-day workshop on November 30th through December 1st, 2011 in which Tor-Forge authors toured the Center and spent time talking with the scientific and technical staff to glean more about their research. The workshop was a unique but focused way of having comprehensive conversations about the future of science and technology research.

Partnering with NASA Goddard Space Flight Center

Companies, organizations, and other entities interested in collaborating with NASA Goddard have a variety of legal instruments available. These instruments, which often include obtaining the rights to commercialize IP developed by NASA Goddard, are designed for specific partnering situations, and include Patent/Copyright Licenses, Space Act Agreements, Cooperative Agreement Grants, and Cooperative Research and Development Agreements (CRADA). Each is intended for a specific purpose and type of partnership.

Space Act Agreements

Among the more commonly used ways to partner with NASA is the Space Act Agreement, designed for collaborations with the public and private sectors. This is a flexible instrument that traces its origin back to the National Aeronautics and Space Act of 1958. A Space Act Agreement defines a set of legally enforceable promises between NASA and its partner. This generally involves a commitment of NASA resources, such as funding, services, equipment, expertise, information, or facilities, to fulfill the objectives of the agreement. A Space Act Agreement is required whenever a partnership entails a commitment of NASA resources for mutual activities beyond appropriated assignments

Space Act Agreements are often categorized in accordance with the type of activity with which NASA is partnering. Other categories include Reimbursable (which provide for payment of NASA`s costs by the partnering party), Non-reimbursable (which requires both NASA and its partner to each to bear the cost of the activity), and Funded (in which NASA provides funding to its partner). Space act agreements are not completed, although NASA can pre-announce intentions to enter into a partnership and welcomes ideas.

Patent/Copyright Licenses

Another frequently used legal instrument for partnering with NASA Goddard is the Patent/Copyright License. A license transfers specific rights of NASA IP for specific commercial use, and is generally royalty-based. Licenses are granted under the authority of 35 USC §§207-209; NASA follows the regulations set forth in 37 CFR §404.

All NASA licenses are individually negotiated with the prospective licensee, and each license contains terms concerning technology transfer (practical application), license duration, royalties, and periodic reporting. Licenses can be exclusive, partially exclusive, or nonexclusive.

The license application process is straightforward. The first step is to complete the License Application, which can be found at http://ipp.gsfc.nasa.gov/partnering.shtm. After NASA receives and reviews the Term Sheet, a marketing plan must be submitted. This requires a detailed description of your plans for the invention. Patents for licensing and software available for copyright are announced in Fed Biz Op and other professional trade publications. This is done to broadcast in the widest way possible the opportunity to license NASA patents.

Examples of Partnering Mechanisms

	Space Act Agreement	Patent/Copyright License	Software Usage Agreement	Cooperative Agreement Grant	CRADA
Purpose	Collaborations with the public and private sector	Transfer specific rights associated with NASA-owned Intellectual Property	Access to NASA developed software	NASA funding provided to facilitate activities that accomplish a public purpose	Used for cooperative research and development whereby it can be established upfront
Competition Required?	In some circumstances	No	No	Generally, Yes	No
Notable Requirements	• Subject to statutory and NASA requirements	• Intellectual Propety • Royalty-based • Commercialization	• Export Control Compliance • Depends on type of release	• Public Purpose • NASA may be involved	• Federal Lab • R&D
NASA Funding to the Non-NASA Party?	Rarely	No	No	Yes	No
Authority	Space Act; NPD 1050.1I	35 USC 207	NPD 2210.1A	Space Act; 31 USC 6304; 31 USC 6305	15 USC 3710a

Other Types of Legal Instruments for Partnering

In addition to Space Act Agreements and Patent/Copyright Licenses, the following legal instruments are also available for partnering with NASA:

- **Cooperative Agreement Grant** is for funding activities that serve a public purpose. These activities may or may not include direct NASA involvement. These agreements are usually competed, and NASA funding is available.
- **Cooperative Research and Development Agreement (CRADA)** is designed for leveraging research efforts that allow jointly owned IP. This type of agreement is used rarely by NASA. Specific research and development objectives and goals are required. A CRADA is not competed, and no NASA funding is available.

NASA Goddard SBIR/STTR Awards

2011 SBIR Phase I

Emergent Space Technologies, Inc.
Greenbelt, MD
TASS-Enhanced Near Earth Navigation System

Keystone Aerospace
Hot Springs, AR
Advanced Exoplanet Star Tracker for Orbit Self Determination

ASTER Labs, Inc.
Saint Paul, MN
Advanced Spacecraft Navigation and Timing Using Celestial Gamma-Ray Sources

Decisive Analytics Corporation
Huntsville, AL
Enhanced Path Planning, Guidance, and Estimation Algorithms for NASA's GMAT

Princeton Lightwave, Inc.
Cranbury Township, NJ
Low-Noise Analog APDs with Impact Ionization Engineering and Negative Feedback

Princeton Lightwave, Inc.
Cranbury Township, NJ
Efficient in-band diode-pumped Q-switched solid state laser for methane detection

Radiation Monitoring Devices, Inc.
Watertown, MA
Modified High Gain APDs for Multi-beam Ladar Instrumentation

Nu Waves Ltd.
Middletown, OH
High Efficiency Switching Power amplifier for Earth Radar Observation System (HESPEROS)

QmagiQ
Nashua, NH
High Temperature and High QE Broadband Longwave Infrared SLS FPA for LANDSAT

AGILTRON Corporation
Woburn, MA
High Performance Spatial Filter Array Based on Signal Mode Fiber Bundle

UNITED SILICON CARBIDE, INC.
Monmouth Junction, NJ
The First Monolithic Silicon Carbide Active Pixel Sensor Array for Solar Blind UV Detection

Prime Photonics, LC
Blacksburg, VA
Bulk metallic glass for low noise fluxgate

Predictive Science Incorporated
San Diego, CA
Anticipating the Geoeffectiveness of Coronal Mass Ejections

HYPRES, Inc.
Elmsford, NY
Low Heat-Leak YBCO Leads for Satellite-Borne ADR Magnets

Biospherical Instruments, Inc.
San Diego, CA
HybridSpectral Radiometer Systems to Support Ocean Color Cal/Val

Southwest Sciences, Inc.
Santa Fe, NM
Robust optical carbon dioxide isotope analyzer

Translume, Inc.
Ann Arbor, MI
Quantitative Nutrient Analyzer for Autonomous Ocean Deployment

HJ Science & Technology, Inc.
Santa Clara, CA
Novel High Pressure Pump-on-a-Chip Technology

AOSense, Inc.
Sunnyvale, CA
Accelerometer for Space Applications Based on Light-Pulse Atom Interferometry

Dallas Optical Systems, Inc.
Rockwall, TX
Diamond Turned Super Alloy Mandrel for Slump Forming X-Ray Observatory (IXO) Mirrors

Flexure Engineering
Greenbelt MD
Cryogenic and Vacuum Compatible Metrology Systems

American Semiconductor, Inc.
Boise, ID
A 45 nm Low Cost, Radiation Hardened, Platform Based Structured ASIC

CrossTrac Engineering, inc.
Sunnyvale, CA
Millisecond X-ray Star Tracker

Maryland Aerospace, Inc
Crofton, MD
Integrated CubeSat ADACS with Reaction Wheels and Star Tracker

Luminit, LLC
Torrance, CA
Carbon Nanotube-based Supercapacitor

EM Photonics
Newark, DE
OpenCL-Based Linear Algebra Libraries for High-Performance Computing

Open Research, Inc.
Gaithersburg, MD
Towards Rapid Application Provisioning in the Cloud

Signal Processing, Inc.
Rockville, MD
High Performance and Accurate Change Detection System for HyspIRI Missions

InterCAX, LLC
Atlanta, GA
SLIM for Agile Mission Lifecycle Management

2011 STTR Phase I

Intelligent Fiber Optic Systems Corporation
Santa Clara, CA
Miniaturizable, High Performance, Fiber-Optic Gyroscopes for Small Satellites

Applied NanoFemto Technologies, LLC
Lowell, MA
Photonic antenna coupled middle-wave infrared photodetector and focal plane array with low noise and high quantum efficiency

EPIR Technologies, Inc.
Bolingbrook, IL
Infrared Microspectrometer based on MEOMS Lamellar Grating Interferometer

Arkyd Astronautics, Inc.
Bellevue, WA
Multi-functional Optical Subsystem Enabling Laser Communication on Small Satellites

2010 SBIR Phase II

Redfern Integrated Optics, Inc.
Santa Clara, CA
Development of a Single-Frequency Narrow Linewidth 1.5mm Semiconductor Laser Suitable for Spaceflight Operation

CoolCAD Electronics
College Park, MD
Novel Silicon Carbide Deep Ultraviolet Detectors: Device Modeling, Characterization, Design and Prototyping

Creare, Inc.
Hanover, NH
An Ultra Low Power Cryo-Refrigerator for Space

Q-Peak, Inc.
Bedford, MA
A LIBS/Raman System for Planetary Surface Measurement

Masstech, Inc.
Columbia, MD
Formaldehyde Profiler Using Laser Induced Fluorescence Technique

Tahoe RF Semiconductor Inc.,
Auburn, CA
Miniaturized Radiation Hardened Beam-Steerable GPS Receiver Front End

Voxtel, Inc.
Beaverton, OR
Large-Area, UV-Optimized, Back-Illuminated Silicon Photomultiplier Arrays

Iris AO, Inc.
Berkeley, CA
Picometer-Resolution MEMS Segmented DM

Applied Material Systems Engineering, Inc.(AMSENG)
Schaumburg, IL
The Conductive Thermal Control Material Systems for Space Applications

Patents Issued

For NASA, New Technology Reports (NTRs) are the critical first step towards detailing and protecting technology developments and innovations. For the third year in a row, the NASA Goddard IPP Office received over 250 NTRs. Each year the IPPO reviews all of the NTRs received and selects a number of them to be patented. NASA Goddard received 22 patents, that were filed in previous years, which are listed below.

Patent Number	Technology Title
7,811,406	Advanced Adhesive Bond Shape Tailoring for Large Composite Primary Structures Subjected to Cryogenic and Ambient Loading Environments
7,817,087	Relative Spacecraft Navigation using Reflected GPS Signals
7,830,527	Method And Apparatus For Second Harmonic Generation And Other Frequency Convertion With Multiple Frequency Channels
7,830,224	Compact Low-loss Planar Magic-T With Broadband Phase And Amplitude Responses
7,886,273	Generation And Verification Of Policies For Autonomic Systems
7,899,760	Autonomic Quiescence
7,904,396	An Autonomic Smoke Detector
7,907,333	A Pulsed, 1 Micron, Single Frequency, Diode-Seeded Ytterbium-doped Fiber Amplifier With Variable Output Parameters, P
7,924,415	Light Direction Sensor
7,922,920	Low Conductance Silicon Micro-leak for Mass Spectrometer Inlet
7,921,731	A two-axis direct fluid shear stress sensor suited for aerodynamic applications
7,924,126	Small, High Field Superconducting Magnets
7,925,600	SWARM AUTONOMIC AGENTS WITH SELF-DESTRUCT CAPABILITY
7,935,297	Template For Deposition Of Micron And Sub-micron Pointed Structures
7,968,812	Spring Joint Package with Overstrain Sensor (“OS Sensor Joint”)
7,970,025	Tunable Frequency-stabilized Laser via Offset Sideband Locking
7,978,312	An Active, Solid-state, 3-Dimensional Range Imaging System
7,979,848	A Method Of Deriving Process Based Specifications From Scenarios Via Pattern Matching
7,982,861	Pseudo-Noise Code Modulation using Return to Zero pulses for Ranging, Altimetry and Communications
7,992,134	Modeling, Specifying And Deploying Policies In Autonomous And Autonomic Systems Using An AOSE Methodology
7,992,760	Hardware And Technique For Dead End Welding Of All Types Of Tubing
7,999,427	Directed Flux Motor Utilizing Concentric Magnets and Interwoven Flux Channels

Business Networking and Outreach

Annual IRAD Poster Session

(December 2, 2011, Greenbelt, MD)

The NASA Goddard Space Flight Center's IPPO exhibited at the Annual NASA IRAD Poster Session. At this event the IPPO showcased opportunities to connect with SBIR awardees. The IPPO aimed to reach out to attendees regarding how IPPO manages partnerships that begin with new technology reporting and protecting intelectual properties. The IPPO staff met with scientists and engineers exhibiting at the poster session, learned of new technologies developed and identified areas where IPPO can potentially help facilitate new partnerships.

IPPO staff members Ted Mecum, Enidia Santiago-Arce and Dr. Bedford Boylston demonstrate the MMO game "Moon Base Alpha" to Annual IRAD Poster Session attendees.

Project Management (PM) Challenge

(February 9-10, 2011, Long Beach, CA)

Project Management Challenge is an annual NASA training event. The theme for this year's PM Challenge was "Explore and Inspire" to acknowledge not only the central role of space exploration to the Agency's mission, but also how the exploration of new ideas and lessons learned in project management increase the chances of mission success. The NASA Goddard IPPO team exhibited and participated in outreach efforts to program and project management attendees to identify technology transfer and sponsored research opportunities.

NASA OPTIMUS PRIME Spinoff School Awards

(May 23-25, 2011, Orlando, FL)

Working with NASA Kennedy Space Center, NASA Goddard IPPO staff members were on hand at Union Park Elementary School in Orlando, Florida, to personally deliver first place awards to four 5th grade students. Isaliz Gonzalez, Grace Romano, Julianna Sanchez, and Samantha Herrod won the NASA OPTIMUS PRIME Spinoff Award Contest for the 3rd - 5th grade category. The NASA OPTIMUS PRIME Spinoff Award Contest is a national video contest sponsored by NASA and toymaker Hasbro. The goal of the contest is to enhance awareness and understanding of how NASA technology 'transforms' into things used daily here on earth. The fifth-graders wrote and produced a video about fabrics created through NASA that protects skin from ultraviolet rays. Each student received a NASA OPTIMUS PRIME trophy, a winner's certificate signed by NASA Administrator Charles Bolden, and passes to tour the Kennedy Space Center Visitors Complex and final space shuttle launch.

Society for the Advancement of Material and Process Engineering (SAMPE)

(May 23-26, 2011, Long Beach, CA)

The IPPO attended the Society for the Advancement of Material and Process Engineering (SAMPE) 2011. This premier conference is held by the only technical society that encompasses all fields of endeavor in materials and processes. SAMPE is an international professional member society that provides information on new materials and processing technologies through commercial exposition, technical forums, and journal publications or books, in which professionals can exchange ideas and views. SAMPE provides a unique and valuable forum for scientists, engineers, designers and academicians and served as a channel for identifying technology transfer opportunities.

Business Networking and Outreach *(continued)*

What's Your Favorite Space?

(August 17th, 2011, New York, NY)

The IPPO played a central role in the success of the "What's Your Favorite Space?" exhibit at the Eventi hotel plaza in New York on August 17th, 2011. As part of a large event celebrating NASA, the IPPO provided a walking gallery of Hubble images, examples of NASA spinoffs, demonstrations of the 3-D Immersive NASA Exploration Game Moonbase Alpha and outreach to the public about technology transfer initiatives.

Innovative Partnerships Program Office (IPPO) staff member Melissa Jackson explains how NASA technologies are used in our homes and in our everyday lives to attendees.

2011 SPIE Optics and Photonics Conference

(August 21 -25, 2011, San Francisco, CA)

Innovative Partnerships Program Office (IPPO) Technology Manager Enidia Santiago-Arce, discusses wavefront sensing technologies with an SPIE conference attendee.

IPPO staff members Enidia Santiago-Arce and Brent Newhall attended the 2011 SPIE Optics + Photonics Conference held at the San Diego Convention Center from August 21 - 25, 2011. The Conference is the largest inter-disciplinary technical conference in North America. NASA Goddard's IPPO hosted a booth detailing the science and technology behind the James Webb Space Telescope. In addition they discussed opportunities for partnership relative to NASA Goddard's "Can You See It Now?" Campaign. This effort is focused on transitioning a deep portfolio of wavefront sensing and adaptive optics technologies, procedures, and lab equipment to private industry.

Emerging Space and Commercial Suborbital Vehicles Workshop

(September 7, 2011, Washington, DC)

The NASA Goddard IPPO and Earth Science Division hosted a Commercial Suborbital Vehicles Workshop at NASA Goddard on September 7, 2011. The purpose of the workshop was to provide information for Earth and Space scientists about vehicles' capabilities and examined and discussed science topics that might be conducted from these platforms. The key opportunities enabled by the unique capabilities of the commercial suborbital vehicles are that they would provide frequent and low-cost access to the mesosphere, lower thermosphere (MLT) region of the atmosphere (50-140km altitude). Atmospheric observations from commercial suborbital vehicles would provide a new window on the MLT. This workshop allowed for an open discussion of platform capabilities versus measurement needs, allowing for any potential design requests to be easily accommodated.

Next Steps in Managing Innovation Workshop

(September 29th, 2011, Pittsburgh, PA)

The Annual Mid-Atlantic Next Steps in Managing Innovation Workshop was hosted by the IPPO on September 29, 2011 in Pittsburgh, Pennsylvania. This outreach event gave SBIR/STTR companies the opportunity to become acquainted with the technology needs of NASA Goddard as well as network with NASA technologists, SBIR Phase III companies, prime contractors, and other organizations that have unique methodologies for advancing technology. This event was a great opportunity to highlights SBIR data property rights, use of NASA Intellectual Property and working with NASA to promote mutual successes.

The annual award recognizes the efforts of an FLC laboratory team that has demonstrated outstanding work in support of science, technology, engineering, and mathematics (STEM) education during the past year.

2011 FLC Mid-Atlantic Region Meeting

(October 4-6, 2011, Cambridge, Maryland)

The 2011 Federal Labs Consortium (FLC) Mid-AtlanticRegion Meeting was held this year in Cambridge, Maryland. Members of the IPPO were presented with the Science, Technology, Engineering and Math (STEM) Award, in recognition of the success of the NASA OPTIMUS PRIME Spinoff Award Video Contest. The contest is designed to emphasize the similarities between the popular OPTIMUS PRIME character from Hasbro's TRANSFORMERS brand and NASA Spinoff technologies now being used back on Earth.

49th Annual R&D 100 Awards Ceremony

(October 13, 2011, Orlando, FL)

The IPPO participated in the 49th Annual R&D 100 Awards Ceremony in Orlando, FL, on October 13, 2011. NASA Goddard received the R&D 100 award in conjunction with our partners at Bartron Medical Imaging, a biotechnology medical device manufacturer with Software Development and Research & Design facilities in Maryland, and Manufacturing facilities in New Haven, CT. Bartron's flagship product, MED-SEG(tm), an FDA cleared medical device incorporates NASA Goddard's Hierarchical Segmentation algorithms developed by NASA Earth Scientists Dr. James Tilton.

Fitz Walker, CEO of Bartron Medical Imaging Inc and NASA Goddard's James Tilton pose with the R&D 100 award they received for their collaboration on medical imaging software.

19th Annual New Technology Reporting Program

(November 8, 2011, Newton White Mansion, Mitchellville, MD)

Deputy Center Director for Science and Technology, Christyl Johnson, and Software Engineering Division Chief, John Donohue, present Dan Smith (Code 580) with the 2011 James Kerley Award, in recognition of his outstanding contributions and support of NASA Goddard's Innovative Partnerships Program.

The IPPO hosted NASA Goddard's 19th Annual New Technology Reporting Program which recognizes innovators who actively support and participate in NASA Goddard's new technology reporting and technology transfer efforts. NASA Goddard Center Management presented patent awards to innovators and the 2011 James Kerley Award to Dan Smith in the software engineering division. The Kerley Award is presented to the individual who has demonstrated outstanding leadership in innovative solutions and participating in technology transfer activities in the past year. This annual event acknowledges the importance in technology transfer and the benefits of partnering.